Air Force SBIR STTR

Advantage

2nd Quarter 2011

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Offering a brief look at the vital research and development contributions made by the Small Business Innovation Research (SBIR) Program in direct support of the Air Force mission.

Induction Thermography System Inspection at Robins AFB, Georgia

PROJECT SUMMARY:

- *The Air Force needs a system that allows a rapid and in situ scan of the vertical stabilizers on aircraft to determine if removal is required*
- *QUEST Integrated, Inc., developed the Induction Thermography System (ITS™) which operates by inductively heating the aluminum honeycomb at the bond interface with a radio frequency wand*
- *The ITS™ technology has been credited with saving an F-15 vertical stabilizer that had been condemned by a tap test*
- *The National Aeronautics and Space Administration (NASA) has purchased two systems, and two major contractors have purchased units for testing the next generation of composite-based commercial aircraft*

Portable Thermal Analysis Microscope

Air Force Requirement

The use of composite materials has improved the performance and capabilities of modern military aircraft. One structure of particular concern is the vertical stabilizer of the F-15 aircraft, with the bonding between the boron/epoxy skin and the aluminum honeycomb being known to degrade over time. These stabilizers are being inspected in situ (i.e., with the staibilizer installed on the aircraft) using a conventional "tap" test method. Once a suspect damaged stabilizer is found, it is removed for a detailed ultrasonic inspection. Unfortunately, the tap test is subject to human error and has problems achieving 100% inspection coverage. Removing the vertical stabilizer for ultrasonic testing is an expensive and time-consuming task that reduces the availability of the aircraft.

The Air Force needs a system that allows a rapid and in situ scan of the vertical stabilizers to determine if removal is required. The system should be used for flight-line inspections in the field, as well as at the repair depot.

SBIR Technology

In this SBIR project, QUEST Integrated, Inc., developed the Induction Thermography System (ITS™) which operates by inductively heating the aluminum honeycomb at the bond interface with a radio frequency (RF) wand. Properly bonded honeycomb panels transfer part of the heat, by conduction, to the boron skin. A sensitive infrared camera is used to image the temperature distribution of the skin. Disbonds do not conduct heat, appear as "cold" or dark spots that are easily detected on the thermal images, and can be marked with a conventional grease pencil on the skin. These areas can then be inspected in detail using a tap test or other nondestructive inspection (NDI) method.

QUEST developed a custom RF power supply that is portable and delivers 2 kW of RF energy in a small lightweight package. In addition, the RF wand is ergonomically designed to allow the operator to use it on vertical surfaces, as well as upward or downward facing horizontal surfaces with comfort over an extended period of time. Along with the heating system, the ITS™ includes an infrared camera, laptop computer, and software for image enhancement and archive reporting of the results.

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SBIR Perspectives

Warner Robins Air Logistics Center

Warner Robins Air Logistics Center (WR-ALC) scientists and engineers (S&E) respond to questions from the SBIR/STTR Advantage editorial staff.

What are your impressions concerning the importance of the Small Business Innovation Research (SBIR) program to the Air Force and, more specifically, to your command?

The SBIR program plays a critical role in assisting WR-ALC in identifying technological opportunities that can assist in solving some of the biggest problems we are faced with today. Any technology developed to meet a need at WR-ALC also has the potential to fill similar needs at other air logistics centers, Army and Navy depots, and for our warfighters. This is particularly true when we look at issues related to troubleshooting, workscope optimizations, failure prognosis, and Condition Based Maintenance (CBM) tools.

As the Air Force works to accomplish its mission with constant shrinking budgets, technologies developed under SBIR program sponsorship assist with identifying and implementing more efficient and cost-effective ways to resolve the technological challenges driven by warfighter requirements.

Compared to larger research and development (R&D) programs, what are some of the special challenges associated with the SBIR program?

In response to identified government topic requirements, the SBIR program is aimed at assisting small businesses to promote new technologies and transition them to the market place. Therefore, it targets a very large pool of small businesses and, by necessity, involves a wide spectrum of topics, limited funding resources, and relatively brief timelines. Acting as a technology "incubator," a SBIR program can spawn larger R&D activities if an innovative concept can be shown to advance the technology base and promise to deliver substantial benefits through further R&D efforts.

A major difference between the SBIR program and a typical large R&D effort is the time required to produce a usable technology. Whereas a major R&D effort may continue for up to ten years before beginning production and fielding, a SBIR project may produce a usable technology in as few as three years. This means that the Air Force realizes the benefits of improved efficiency and effectiveness of using the new technology sooner and the small business is hopefully able to commercialize the technology to return further value to its investors.

How does your Center identify its prospective SBIR topics?

We use a robust process of surveying the weapons system program offices located at the Center, the Maintenance Wing, and the Air Base Wing to identify any potential needs that could be filled by technology solutions. Each submitted idea is reviewed and compared to the Center's master technology list. The potential projects are then prioritized according to the Center's master priorities.

Jorge F. Gonzalez, a member of the Senior Executive Service, is Director of Engineering and Technical Management at the Warner Robins Air Logistics Center, Robins AFB, Georgia. He serves as the Science and Engineering focal point for standardized engineering policies and processes.

"WR-ALC uses the SBIR and other technology insertion programs to bring older technologies up to today's standards and to integrate advanced technologies into existing practices to reap benefits in terms of optimum repair, overhaul and scheduling, manufacturing and improved system reliability, safety, and maintainability," notes Mr. Gonzalez. "The SBIR program is an important source of funding for the Center's technology insertion efforts, which makes it a major contributor to achieving our objectives of improving the efficiency of our support to the warfighters."

What is the role of the technical point of contact (TPOC) in managing WR-ALC's SBIR projects?

The WR-ALC TPOCs identify technology needs; communicate with industry, academic, and military experts; prepare candidate SBIR topics for consideration; assess proposals; monitor SBIR contracts and the performance of contractors; and lead the transfer of technology to our weapons systems and maintenance organizations. The basic ingredients for successful technology insertion activities at WR-ALC consist of strong technical leadership, a robust agenda requirements process that recognizes the needs of the Air Force and the Center, partnerships with other Department of Defense (DoD) and industry organizations, active participation by internal and external parties, and a clear vision of short-term and long-term benefits to our customer base.

System Program Offices (SPOs) have the engineering authority for evaluating and approving technologies for insertion into weapon systems. Hence, whenever possible, SPO engineers are the TPOCs for WR-ALC's SBIR projects, working directly with the small businesses to ensure that the technologies they develop meet the needs of their specific weapons system. In the cases where an engineer outside of a SPO serves as the TPOC, the TPOC works to establish

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a close partnership with the SPO system engineers and the maintenance production personnel to ensure optimum efficiency in utilizing the newly developed technologies.

What factors impact the prospects for SBIR technology transition?

The major factor impacting the transition of technology is funding, particularly in today's fiscally constrained environment. Once a technology is proven in general or for a specific application, we have to find funds to apply it to applicable weapons systems. Even when it is developed for a specific application, we have to ensure that appropriate funding is available to accomplish technical order updates required to tell the Airman on the flight line or the mechanic in the depot how to use the technology. Without the correct technical data being available, the new technology sits on the shelf waiting to be used.

In some cases, we need to ensure that the original equipment manufacturer for a weapons system is properly incentivized to work with the small business to implement a new technology. Moreover, we have to work with all of the stakeholders involved with any new process (that we are considering for a technology insertion effort) to gain the requisite "buy in" as early as possible.

When you think of a successful SBIR project transition and payoff, what example comes to mind?

The WR-ALC Aerospace Sustainment Directorate sponsored the development of metal fiber brushes as a means to reduce the C-130 aircraft maintenance burden. Metal fiber brush technology was proven through developmental testing under the U.S. Navy SBIR program. Capitalizing upon the earlier Navy SBIR results, the Air Force Commercialization Pilot Program (CPP) provided supplemental SBIR funding to advance this Phase II Air Force SBIR project.

Transitioning from carbon brushes to metal fiber brushes will result in a 2-to-1 cost savings in spare parts alone. Further cost savings result from fewer inspections and increased operational availability of the platform. The technology can be transitioned to any propeller de-icing system, any slip ring system operating in severe environments, or any system requiring significant performance attributes where carbon brushes do not satisfy the requirement. Metal fiber brushes are currently deployed in the U.S. Navy submarine fleet in critical nuclear propulsion plant components on three separate submarine classes.

Does your command sponsor conferences or workshops that provide good opportunities for small businesses to interface with your scientists and engineers concerning current or future SBIR projects? If so, what are some of these?

One method WR-ALC uses to develop and cultivate new relationships is to conduct an annual Requirements Symposium each November. The Requirements Symposium allows the Center and attendees to share information concerning future requirements, technology needs, and technology capabilities. WR-ALC fosters collaborative relationships through formal and informal meetings, as well as active participation in individual projects. In addition, the WR-ALC SBIR office has established a continuous dialogue with other Air Force units and academic and industry experts.

SBIR Spotlight

Brief profiles of companies that currently participate in the SBIR/STTR contract process

MZA Associates Corporation, Albuquerque, NM

Adaptive optics (AO) beam control is required for aircraft-based laser directed energy systems to maintain laser optical quality while traversing the path from aircraft to target. MZA Associates Corporation developed and tested its adaptive control technology, thereby establishing MZA as a leading innovator in aero-optics compensation by use of AO. Adaptive control is the logic and accompanying computer software which connects measurements of optical disturbances made by the laser beam control system's wavefront sensor with the commands sent to the deformable mirror which corrects the laser for optical distortions. The system degradation associated with AO latency can be reduced by use of adaptive control, which implements a predictive adjustment to the current update of the deformable mirror, given a recent time history of wavefront sensor measurements and computer processing to develop the proper wavefront filter.

MZA plans to apply adaptive control in its wave-optics simulation work for technology insertion into tactical beam control programs. With the AO control software and the aircraft deformable mirror technology, MZA will be able to offer a high-performance AO capability to be integrated into future laser beam control systems. The AFRL Directed Energy Directorate manages this SBIR project under topic number AF06-006. Visit MZA Associates Corporation at www.mza.com.

Air Force SBIR/STTR Success Stories

Success stories can be found in the Publications section of the Air Force SBIR/STTR Website (www.afsbirsttr.com). The stories are posted in the innovation and transition electronic file folders. Success stories are also available in the Topic/Award Data Search section, where they can be accessed by the small business firm's name and the SBIR/STTR topic number.

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Transition Impact
The ITS™ technology has already been credited with saving an F-15 vertical stabilizer that had been condemned by a tap test. The ITS™ inspection contradicted the original findings and alerted the NDI team to re-examine the vertical stabilizer which was found to be sound. The cost savings of this one incident alone more than off set the SBIR funding investment. In addition, the system has proven to be useful in verifying the structural integrity of boron laminate patches used to repair bullet hole damaged skins. The ITS™ can visualize the final placement of the patch over the hole, and indicate which parts of the patch have poor adhesive bonds to the underlying skin.

The ITS™ heating concept can be applied on any electrically conductive reinforcement or element within or in contact with a composite structure. NASA has purchased two systems. One unit at the Jet Propulsion Laboratory in Pasadena, California, is being tested for verifying the integrity of rocket fuel tanks for deep space probes. These tanks are composed of carbon-wrapped titanium shells of extremely thin sections. Here, the integrity of the bond between the carbon-wrap and the titanium skin is critical for the tank's long-term performance. NASA Langley is evaluating the ITS™ for testing various components on the space shuttle. In addition, Boeing and Airbus Industries have purchased units for testing the next generation of composite-based commercial aircraft.

Company Impact
This SBIR program has enabled QUEST to offer a complementary NDI tool to its Magneto-Optical Imager (MOI™) system for aircraft inspections. The MOI™ is used by the Air Force and commercial companies for inspecting cracks in riveted aluminum airframes, and is widely acknowledged to be the only system capable of rapidly scanning large areas for flaws. With the addition of the ITS™ product line, QUEST is well positioned to support the transition of airframes from aluminum structures to composite structures that will mark a major milestone in the advancement of airframe technology.

SBIR Topic Number:
AF02-282

Title:
Inspection of Aircraft Composite Components

Contract Number:
F09650-03-C-0035

Company Name:
QUEST Integrated, Inc., Kent, WA

Technical Project Office:
Warner Robins Air Logistics Center, Robins AFB, GA

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nLIGHT Corporation, Vancouver, WA
With satellite communications data rates anticipated to grow exponentially for the foreseeable future, the Air Force is interested in developing the capability for satellite based laser communications (SATCOM). Due to their lightweight and small size, diode pumped fiber amplifiers are highly suited for use in SATCOM laser communications applications. High-power fiber amplifiers, pumped by high-power single emitters, have demonstrated their advantages in terms of reliability as an optical source for laser communications.

nLIGHT Corporation combined its nLIGHT design and production experience in high-reliability, single-emitter, fiber-coupled, laser diode module packaging with its expertise in high-power, wide-stripe, super-high efficiency diodes (SHEDs). nLIGHT was able to produce a space-qualifiable, high-power, single-emitter, fiber-coupled, laser diode module. Existing space and telecommunications proven packaging processes were modified for use with high-power, wide-stripe laser diodes. The package design uses high thermal conductivity and expansion-matched materials in a low-thermal resistance topology with high electrical conductivity to minimize laser diode junction heating.

This product fundamentally advances the ability to create high-power, directed energy class, fiber laser systems. The laser module can also be used for optical communications, as well as multiple medical and materials processing applications. The AFRL Sensors Directorate manages this SBIR project under topic number AF063-003. Visit nLIGHT at http://www.nlight.net.

U.S. AIR FORCE

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Air Force SBIR/STTR Advantage

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The goal of the Air Force SBIR Program is to serve the technology needs of Air Force warfighters. It accomplishes its mission as part of the Air Force Research Laboratory's (AFRL) integrated research and development (R&D) team. AFRL's mission is leading the discovery, development, and integration of affordable warfighting technologies for our air, space, and cyberspace forces.

SBIR Advantage is published quarterly by the Air Force SBIR Program office. This publication offers an overview of AF SBIR issues and information.

The purpose of SBIR Advantage is to provide Air Force, DoD, and other government leadership with additional insight into the vital contributions made by the SBIR program to Air Force R&D.

SBIR Advantage is available online at:
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